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MADHAV M. DESHPANDE

Several rules in Pāṇini's grammar presuppose the existence of a detailed system of phonetic features. Since some of these are metalinguistic rules-- they specify how regular rules in the grammar are to be interpreted -- this featural system can be said to form an essential component of Pāṇinian grammar. Realizing this, it comes as at least a mild shock to discover that Pāṇini has nowhere explicitly described this system.[1] Nor, apparently, did he directly bequeath knowledge of it to his earliest commentators, for they often show confusion as to its details. The whole dizzying edifice of Pāṇinian grammar seems thus to rest upon a hidden foundation!

Luckily, with a bit of careful digging, a good part of Pāṇini's groundwork can be laid bare. We can refer to the featural systems of the ancient phonetic treatises, the Śikṣās and the Prātiśākhyas, and speculate that Pāṇini's system was probably similar, especially since the few featural terms he uses have parallels in these treatises. While one cannot be totally certain that these phonetic treatises, in their presently known form, are entirely pre-Pāṇinian, one can be certain that the tradition of phonetic analysis and description to which they belong is indeed pre-Pāṇinian. One can fruitfully compare these systems with Pāṇini's system, and one can also attempt to deduce Pāṇini's phonetic classifications, using the few clues that he has left for us.

Some of these lines of inquiry have been followed in the previous research on this subject.[2] In the present paper, I shall not go into the detailed, and sometimes convoluted , arguments made in the previous research publications by the various scholars, including myself, but will only refer to some of the conclusions of this previous research and move on to dealing with some theoretical considerations arising from the form of Pāṇini's featural system and the way in which Pānini used it in grammar. Here, we shall only broadly touch upon the various issues, which have been discussed at length elsewhere, and perhaps need to be discussed futher in greater detail.

The version of Pāṇini's featural system adopted by most of the later commentators can be shown, through various deductive arguments, to at least closely approximate the origionl system Pāṇini may have had. This is not surprising, considering the many centuries of critical examination it has been subjected to by the various commentators. However, the deductive arguments also seem to suggest that Pānini's original system was not totally identical with the one ascribed to him by the later commentators. This is indicated by the fact that the system ascribed to Pānini by these later commentators is at odds with certain considerations internal to Pāṇini's grammar. In order to present an approximate picture of Pāṇini's original system, it is best to begin with the system ascribed to him by the later commentators, and then to look at its various problem areas.

We shall take a close look at the phonetic system as presented in Bhaṭṭojī Dīkṣta's *Siddhānta-Kaumudī*[3] mostly on rules P.1.1.9 (*SK* no. 10). P.8.4.68 (*SK* no. 11), and P.8.2.1 (*SK* no. 12). Bhaṭṭojī recogizes three major featural parameters--points of articulation (*sthāna*), internal effort (*ābhyantara-prayatna*), and external efforts (*bāhya-prayatna*). The term 'external effort' refers to a whole set of parameters rather than a single parameter.[4] The point-of-articulation features are assigned as follows : throat : *a,k,kh,g,gh,ṅ, h, ḥ*; root of the toungue: $_{x}k$; palate: *i,c,ch,j,jh,ñ,y,ś;* cerebrum : *ṛ, ṭ, ṭh, ḍ, ḍh, ṇ,r,*ṣ; teeth : *ḷ,t,th,d,dh, n,l,s*; lips : *u,p,ph,b,bh,m,* $_{x}p$; nose : m.[5] The nasal stops also have the nose as a second point-of-articulation feature, however, the categorization of nose as a point of articulation raises some imporatant problems. The sounds *e* and *ai* are both said to have the throat and palate, and *o* and *au* both the throat and lips as points of articulation. The consonant *v* is said to have a double points of articulation-- teeth and lips.

Internal effort is fourfold : contact, assigned to stops : slight contact, assigned to semivowels; openness, assigned to both spirants and vowels (except short *a*); and closeness, assigned to short a.[6] These classifications are displayed in the following chart :

Bhaṭṭojī lists eleven external-effort features: openness (of glottis), closeness (of glottis), breath, tone,+voice, light breath (-aspiration), great breath (+aspiration), acute, gravė, and circumflex. The unvoiced stops and the unvoiced spirants have the features of openness, breath, and -voice. The remainder of the consonants have the features of closeness, tone and +voice. The unaspirated stops, both voiced and voiceless, the nasal stops, and the semivowels have the feature of

Points → **Effort ↓**	**Throat**	**Root of**	**Palate**	**Cerebrum**	**Teeth**	**Lips**	**Nose**
Contact	k kh g gh ṅ		c ch j jh ñ	ṭ ṭh ḍ ḍh ṇ	t th d dh n	p ph b bh m	ṅ ñ ṇ n m
Slight Contact			y	r	lv	v	
Openness	h ḥ a e o ai au	$_{x}k$	ś i e ai	ṣ ṛ	s ḷ	$_{x}p$ u o au	ṃ
Closeness	a						

light breath (- aspiration). The remainder of the consonants have the feature of great breath (+ aspiration). Acute, grave, and circumflex are prosodic features of accent and apply to vowels only. Of the earlier features, the features of closeness of glottis and the resulting tone or resonance also apply to vowels. The vowels may also be said to have light breath . However, among vowels, all the instances share these features, and therefore, they do not distinguish one set of vowels from another set of vowels.[7]

Before venturing on a brief tour of the problem areas contained in this version, it would be well to restate exactly what it is that we mean by the term "problem area". Since we are only intrested, for the moment, in discovering Pāṇini's original classificatory intentions, problem areas are those where the later classifications are suspicious, due to questions of consistency within the grammar. There are some areas where modern linguists would wish to question the rationale behind Pāṇini's featural classifications. However, for the present concern, these are not to be viewed as problem areas, if it is sufficiently clear that they reflect Pāṇini's classificatory intentions. A good example of this distinction is Pāṇini's supposed division of the internal-effort parameter so as to give spirants and vowels the same feature of internal effort, that of openness. Although this is puzzling to modern eyes, there is precedent for it in the phonetic treatises, and sufficient evidence within Pāṇini's grammar itself to suggest it as indeed being Pāṇini's intended classification.[8]

There is no lack of problematical classifications, however. The following list gives a brief treatment of these problematical classifications:

(1) Throat as the point-of-articulation feature for the *k*-class of stops. Most of the phonetic treatises have it as the root of the tongue, and there is some evidence within Pāṇini's grammar that supports this latter alternative.[9]

(2) Dual point-of-articulation features for nasal stops. This classification would probably give rise to problems within the grammar. An alternative, as found in some phonetic treatises, might have been to distinguish nasality along some other featural parameter, such as the articulator, rather than as a point of articulation. However, no clear evidence to decide between the different alternatives can be offered.[10]

(3) Dual point-of-articulation feature for *v*. There is a good deal of evidence, though not uncontested, to classify *v* not as labio-dental, but as purely labial.[11]

(4) Dual point-of-articulation features for *e* and *o*. This classification leads to problems within the grammar. There is some evidence, through not totally conclusive, that Pāṇini intended these sounds to be treated as monophthongal, i.e., palatal only and labial only, respectively.[12]

(5) Same internal-effort feature for diphthongs and simple vowels. This also leads to problems within the grammar. A possible alternative, having precedent in the phonetic literature, is that Pāṇini set of *e, o, ai*, and *au* from the other vowels by means of another internal-effort feature. Again we have no conclusive evidence within the grammar.[13]

The system which emerges, however obscurely, from these considerations obviously bears strong resemblance to the point-of articulation/mode-of-articulation phonetic charts of the pre-generative era. Non-binary features, although lacking a certain cybernetic efficiency, do not seem to have interfered with the phonological roles Pānini chose for his features to play, though they may have limited the extent of these roles, as we shall see below.

The system as such cannot be called innovative, since its general shape as well as almost all its particular classifications have close parallels in the phonetic treatises.[14] Indeed, at times one feels that Pāṇini is going through a great deal of effort to preserve some inherited classifications, even while realizing the problems it posed to the phonological operation of the grammar. A good example of this is the lack of distinction between vowels and spirants along the parameter of internal effort. It is almost as if Pānini, like modern phonologists, wanted to make sure that his featural system was basically phonetically motivated; i.e. decided upon a purely phonetic examination of sounds before reference was made to its convenience in describing the phonological connection.

If it is true that Pāṇini did choose, for whatever reasons, a featural system that was quite closely bound by the precepts of traidtional Indian phonetics, two questions come to mind: (1) How heavy could the functional load of such a system be within a grammar that was truly innovative ? (2) What limitations, both theoretical and mechanical, did the utilization of such a system impose upon the grammar?

The answer to the first question to a certain extent vindicates traditional Indian phonetics as well as Pāṇini's apparent conservatism, for the scope of application permitted by his choice of this particular system is actually quite broad. Pāṇini's use of features is basically towfold: (1) He defines certin types of natural classes in terms of features so that these classes may be utilized in rule statements. (2) He uses features as a means by which many single-sound substitution rules can be combined into a unified, more general class-substitution rule.

Pāṇini uses two kinds of featurally-defined natural classes. In the first of these, he incorporates a term derived from a point-of-articulation feature in the rule itself in order for it to represent all sounds having that particular feature. This usage occurs in only three rules, however, and thus has somewhat limited significance. The terms used are 'labial' *(oṣṭhya)*, 'dental' *(dantya)*, and 'cerebral' *(mūrdhanya)*.[15]

The second kind of natural class results from Pāṇini's definition of the term 'homogeneous' *(savarṇa)*, through which sounds having a common point-of-articulation feature and a common internal-effort feature are grouped together as homogeneous sounds. By this means short and long vowels are grouped together as a class (e.g., *a* and *ā*, *i* and *ī*, etc.); likewise stops sharing a particular point-of-articulation feature (e.g., *k,kh,g,gh,* and *ṅ*). Classes of this type are usually represented in rules not directly by featural terms, but by specified tokens to represent the types or classes. For example, *a* stands not only for itself, but for the whole class of eighteen homogeneous sounds :

a ā ā3 á ā́ ā́3 à ā̀ ā̀3 ã ā̃ ā̃3 ã́ ā̃́ ā̃́3 ã̀ ā̃̀ ā̃̀3

Similarly, the consonant *k*, with a marker *U* attached to it, i.e. *kU*, represents the group of homogeneous consonants, i.e. *k, kh, g, gh,* and *ṅ*.[16]

This is the extent of Pāṇini's employment of featurally defined natural classes. He of course needed to have a means by which other classes than these could be represented in rules, and for this he devised an ingenious indexing device which is not directly based on features. This device lists the sounds of Sanskrit in a certain order with various index sounds inserted at key points, thus:

1. *a i u Ṇ*
2. *ṛ ḷ K*
3. *e o Ṅ*
4. *ai au C*
5. *h y v r Ṭ*
6. *l Ṇ*
7. *ñ m ṅ ṇ n M*
8. *jha bha Ñ*
9. *gh ḍh dh Ṣ*
10. *j b g ḍ d Ś*
11. *kh ph ch ṭh th c ṭ t V*
12. *k p Y*
13. *ś ṣ s R*
14. *h L*

These fourteen sound-strings are the famous *Śivasūtras*, traditionally believed to have been given to Pāṇini by Śiva.[17] When Pāṇini wanted to refer to a certain class by means of this device, he used what can be called a shortform (*pratyāhāra*), consisting of any one of the listed sounds (except the marker sound given here as upper-case letters) as the first sound, together with any one of the subsequent marker sounds. Such a shortform represents all the sounds beginning with the first sound of the shortform up to the given marker sound, excluding the marker sounds themselves. For example, *aC* is a shortform used to represent *a, i, u, ṛ, ḷ, e, o, ai,* and *au.* The shortform *ñ(a)M* represents all the nasal stops.

It can be ascertained by an examination of the grammar that most of the classes represented by means of this device are what we would want to call natural classes, and could therefore be represented by means of some feature-based device. The question then, of course, is why Pāṇini chose to represent some classes by means of features and not others. One might mistakenly expect the answer to have something to do with the limitations of Pāṇini's featural system, i.e. that it was not versatile enough to allow representation of other types of classes. This, however, is clearly not the case. The system, inasmuch as we can pin it down, would have allowed featural definition of nearly every natural class actually represented by means of the indexing lists of shortforms.

The real answer evidently is that since Pāṇini's grammar, as all other scholarly works of the time, was designed for oral transmission, brevity of rule formulation was a priority consideration. That is, even though *jhaṢ* was perhaps not as theoretically elegant a class marker as 'voiced aspirate stop' or its Sanskrit equivalent, it certainly was shorter and easier to memorize as part of a rule. In addition, although featural reference was possible by means of the featural system Pāṇini chose, in some cases such reference would have been especially unwieldy, due, among other things, to the basic nonbinary set-up of the system. For example, the class referred to by Pāṇini as *śaR* - *ś, ṣ* and *s* -- could indeed have been defined featurally by some sort of listing of each segment's features, e.g., palatal, cerebral, and dental open unvoiced aspirates, or some such. This, in fact, is one of the main drawbacks of nonbinary system - every feature along a given parameter is assumed to have equal affinity with all the other features along that parameter, so that classes formed from a subset of all the features along the parameter are marked, through the unwieldy necessity of listing the individual segments' features, as being nearly as unnatural as a class of unrelated segments. That is, the class, *ś*, *ṣ*, and *s* is nearly as difficult to describe featurally as the class *a*, *y*, and *d*. One may feel that one could featurally describe the class of *ś*, *ṣ*, and *s* by the description a*ghoṣa ūṣman* 'voiceless spirants'. However, this will also include the sounds *h*, ₓ*k*, and ₓ*p*. To exclude these, one indeed needs to make some unwieldy efforts. It is thus probable that the shape of the system chosen by Pāṇini did put some constraints on his use of features in defining natural classes, but considerations of brevity were still probably the more important ones for him. That is, even had the system chosen been binary, the indexing list would most likely still have been the prevalent mode of class representation.

For those classes where Pāṇini did have recourse to features, the rationale seems to have been either impossibility of reference by means of the indexing list (as for classes based on point-of-articulation features) or realization of the fact that certain classes appeared in rules much more often than any individual members or subsets of those classes (e.g., a rule is much more likely to deal with all the varieties of *i*--*i*, *ī*, *ī3*, etc. -- than any single variety or subset of varieties).[18]

Thus, even though featurally-based classes take something of a secondary role in Pāṇini's grammar, the important thing is that he realized that features could be useful in this function. His use of shortforms in preference to features is indicative not of theoretical naiveté, but rather of practical craftsmanship and regard for the milieu in which he found himself working.

Apart from class-formation, Pāṇini uses features as a means by which many single-sound substitution rules can be combined into a single class-substitution rule. He achieves this through a rule-interpretation device known in Sanskrit as *āntaratamya*, which may be literally translated as 'substitution of the most similar'. This device provides a criterion for deciding which of a class of possible substitutes should be chosen for a given substituendum -- the criterion being greatest featural similarity or proximity.[19] For example, if a rule states that the class *i*, *ī*, *u*, *ū*, *ṛ*, *ṛ* and *ḷ* is to be replaced by *y*, *v*, *r*, and *l*, when followed by a vowel, substitution of the most similar would operate to specify *y* as the proper substitute when *i* or *ī* is the substituendum, *v* when *u* or *ū* is the substituendum, etc. The "greatest similarity or proximmity" in this case would of course result from the fact that *y* is featurally more similar to *i* or *ī* than is any of the other possible substitutes, the point of articulation feature 'palate' being held in common. Thus, instead of having to state four separate rules --

i, *ī* ⇨ *y*/ -*V*

u, *ū* ⇨ *v*/ -*V*

ṛ, *ṛ* ⇨ *r*/ -*V*

ḷ ⇨ *l*/ -*V*

Pāṇini, by means of this device of maximal featural proximity, not only could satisfy his self-imposed conditions of economy of rule statement, but was also able to capture a linguistically significant generalization that the other means of statement would have missed.[20]

It is interesting to note that modern phonology uses features in rule statements to fill these same two basic needs -- the representation of natural classes and the combination of analogous processes into a unified, general rule. The difference is that Pāṇini seems not to have seen these two as aspects of the same thing, as does modern phonology, where a single device -- rule statement *in terms of features* -- meets both these needs. This difference is theoretically crucial. Pāṇini saw features as facilitators for rule statements, but felt the statements themselves to properly concern segments, whereas modern phonology sees rule statements as being about features rather than segments. The devices used by Pāṇini show that he came extremely close to making this connection himself; the fact remains, however, that he never took the final step. This may indeed have had something to do with the prevalent oral tradition of the time, where considerations of brevity and mnemonic ease were probably just as important as the theoretical ones. Certainly most of Pāṇini's phonological rules would, from this point of view, have been more unwieldy if stated in pure featural terms. It is also the case that Pāṇini could express everything that he needed to express within his grammatical system by means of the devices he adopted. He did not concern himself with extra-grammatical topics like historical change, where rule statement in terms of features might have enabled greater generality of expression, and also may have provided a greater insight into the causation of sound-change. If this is valid, we can say that Pāṇini, through the devices in which he utilized features, got as close to the notion of rule statement in terms of features as his times and focus allowed him to.

Even though the extent to which Pāṇini utilizes features in his grammar is somewhat more limited than in modern phonological practice, the mere fact of utilization led him to struggle with a problem that has plagued phonologists to this day - how to reconcile phonetics and phonology? That is, how does one relate, through a single featural system, the phonetic "facts" and the phonological requirements of a grammar when the two often seemingly demand different featural classifications for the same sound?

The phonological demands upon Pāṇini's featural system were directly determined by the ways in which Pāṇini chose to utilize the system in his grammar. These demands, articulated as ideal expectations, are basically of two types : (1) Where Pāṇini uses features to define classes, the implicit demand upon the system is that all the resultant classes be phonologically desirable, i.e., useful in the statement of rules, and, conversely, that all the relevant desirable classes result from the basic featural definition. (2) Where Pāṇini uses featural proximity as a means for determining which of a class of substitutes is to be chosen for a given substituendum, the implicit demand upon the system is that it provide a basis whereby the single desired substitute can be identified as the "most similar or proximate" to the given substituendum.

Pāṇini seems to have had more trouble dealing with the demands imposed by (1) than with those imposed by (2). The most glaring problem was probably that vowels and spirants sharing the same point of articulation were classed together as homogeneous sounds by virtue of their sharing the same feature of internal effort. Since pairs like *h* and *a* (and *ḥ* and *ā*), *ś* and *i*, etc., were obviously undesirable from a phonological point of view as pairs of homogeneous sounds, Pāṇini was constrained to attach as a condition to his basic featural definition of homogeneity a statement to the effect that homogeneity could not obtain between vowels and consonants.[21]

We can identify at least three other areas where the phonetic conditions for homogeneity seem to be met and yet homogeneity must be considered undesirable from a phonological point of view. Unfortunately, in none of these areas can we be certain how Pāṇini himself chose to resolve the dilemma, due to lack of evidence within the grammar. The first of these areas is that of the diphthongs. We do not know Pāṇini's exact phonetic intentions in this area, but we do know that the classifications found in some of the phonetic treatises would have led to solutions of these problems. We also know that Pāṇini intended no homogeneity among the sounds *i*,*e*, and *ai*, or *u*, *o*, and *au*. There is some evidence, as stated above, that Pāṇini used phonetic criteria to distinguish *ai* and *au* from the others, but we really have no way of knowing how he dealt with *i* and *e*, or with *u* and *o*.[22]

A possible area of this type is that having to do with *h* and *ḥ*. We know that if Pāṇini followed the classifications of the great majority of phonetic treatises here, these sounds would meet the phonetic criteria for mutual homogeneity. It is also the case that such homogeneity must be judged undesirable from a phonological standpoint. Here again we do not know how Pāṇini chose to handle this. A check through the grammar shows that even if Pāṇini allowed the theoretical problem of undesirable mutual homogeneity to remain, no serious practical malfunction of the grammar would result, due to the almost mutually exclusive contexts, both phonetic and phonological, in which *h* and *ḥ* can appear.[23]

Pāṇini probably faced another dilemma when dealing with the nasalized sounds -- the nasal stops, semivowels, and vowels. Certain early phonetic schools conceived of these sounds as having two points of articulation, an oral one and the nose.[24] However, such a phonetic classification would have led to two types of phonological complication with respect to homogeneity. On the one hand, Pāṇini demonstrably wanted mutual homogeneity between nasal and non-nasal stops having the same oral point of articulation (likewise with semi-vowels and vowels); on the other hand, there is no indication that Pāṇini wanted mutual homogeneity among all the nasal stops (or semivowels or vowels). Again we cannot be sure how Pāṇini chose to handle this. He might have implemented a non-problematical phonetic classification by giving these sounds only oral point-of-articulation features and then accounting for the nasality distinction along a featural parameter that did not figure into the definition of homogeneity. On the other hand, he may indeed have adopted the problematical phonetic classification and chosen to deal with the problem by putting an implicit constraint on the phonological operation of the grammar, possibly to the effect that the nose as point of articulation feature was to be excluded from calculations of homogeneity.[25]

There is at least one other area where the phonological requirements of homogeneity and the phonetic "facts" are apparently in conflict -- the classification of short *a*. Here Pāṇini realized that homogeneity between short *a* and long *ā* was desirable, since on a phonological level they behaved as similarly as, say, short and long *i*. However, short *a* was phonetically classified with a different internal effort feature than that of the remainder of the vowels, including long *ā*, and consequently did not meet the phonetic requirements for homogeneity with long *ā*.[26] Pāṇini's solution to this is interesting and unusual. He classified short *a* with the same feature of internal effort as that of long *ā* so that the deisred homogeneity would be obtained, and then he formulated a rule, which in effect applied at the end of every derivation, to return the classification of short *a* to its more proper phonetic value. In instituting a different classification at each level, Pāṇini hit upon a way of expressing rather than avoiding the problem, and thus found a solution that was both descriptively and theoreticlaly pleasing.

The phonological requirements of *āntaratamya* ('subsititution of the most proximate') would seem to be such that a number of problem areas might be expected here also, since phonetic and phonological similarity or proximity are not always equivalent. Many of these potential problem areas never seem to manifest themeselves, however, probably due to controlling this device through individual rule statement. Despite this, there are a few items of interest that deserve mention.

It is indeed a possibility that Pāṇini was led to his labial point-of-articulation for *v* through phonological considerations having to do with *āntaratamya*, i.e., so that *v* would be more similar to *u* than to any other vowel.[27] Similar considerations might have contributed to the cerebral classifications for r and ṛ, the usual classification for these sounds in the prātiśākhyas being non-cerebral.[28] It seems doubtful, however, that Pāṇini,usually rather conservative in his other phonetic classifications, would have been willing to make such shifts in these classifications unless there was a factual basis for them.

The picture emerges, from all this, of a pioneer phonologist cautiously feeling his way through this territory. From our modern perspective, we can perhaps detect certain limitations in Pāṇini's approach. But, surely, even the fact that Pāṇini's featural system, both in shape and utilization, can be discussed in terms that are not too alien to modern sensitivities is little short of remarkable. How much more so when we come across solutions in Pāṇini that can still stand up to the latest theories in phonology.

NOTES

1. Traditionally, the *Pāṇinīya-Śikṣā* is cited as the means by which Pāṇini filled this gap. It is now generally accepted, however, that this is in fact a later work which considerably post-dates Pāṇini, and is not known even to Patañjali.

2. George Cardona (1969), Madhav Deshpande (1975), and James Bare (1976).

3. Here we shall not concern ourselves with the question of sources of Bhaṭṭoji's classifications, but shall deal with the classifications offered by Bhaṭṭoji as reflecting 'his ' system in a synchronic sense.

4. The distinction between 'internal' versus 'external' efforts is most probably not historically a Pāṇinian distinction, but is made explicity by Patañjali in his discussion on P.1.1.9.

5. The sound *k*, phonetically [*X*], and *p*; phonetically [*o*], are contextual variants for *visarga*, h.

6. The traditional grammarians, including Bhaṭṭojī, make the assumption that short *a* was a close sound in actual usage, but that within the confines of grammatical derivation, it was considered to be-or perhaps pronounced-an open vowel, in order to achive its necessary homogeneity (*sāvarṇya*) with *ā* by P.1.1.9. (*tulyāsyaprayatnam savarṇam*). The final rule of Pāṇini's grammar restores the close *a* in all derivations, before they become usable.

7. A modern Indian Pandit, Jagadīśācārya Citrācārya, in his Sanskrit work *Śikṣāśāstram* (p. 13) says :*tatrodāttānudāttasvaritās trayaḥ svarāṇām eva sarveṣām /śeṣā aṣṭau vivārādayo vyañjanānām eva.* This is clearly mistaken in denying vowels the features of glottal closure and resonance.

8. Bare (1976), pp. 113-115.

9. Bare (1976), pp. 126-130.

10. Deshpande (1975), pp. 11-12; Bare (1976), pp. 130-140.

11. For a detailed discussion, see Deshpande (1975a) and (1981); Bare (1976), pp. 160-171; Cardona (1964).

12. Deshpande (1975), pp. 138-140; Bare (1976), pp. 187-191; Cardona (1983).

13. Bare (1976), pp. 191-192; Cardona (1983).

14. For a general descripition, see Allen (1953) and Bare (1976).

15. The rules are respectively P.7.1.102, P.7.3.73, and P.8.3.55

16. This procedure of representation of the homogeneous sounds by a specified token is prescribed by P.1.1.69. For a detailed study of the notions of *savarṇa and savarṇa-grahaṇa*, see: Deshpande (1975)

17. For a detailed study, see George Cardona(1969). The most recent study of these strings is Kiparsky (1991). Other studies of these strings are listed by Cardona and Kiparsky.

18. Since *i* in a rule represents the whole homogeneous class when Pāṇini did want to refer to just *i* or just the short varieties, he had to have recourse to a special device in order to do so. Through the use of the marker *T*, a sound was enabled to represent homogeneous sounds of the same length. For a detailed study of this procedure, see Deshpande (1972).

19. Bare (1976), pp. 99-111, discusses the various problems involved in our understanding of this procedure.

20. This is a very diluted presentation of the operation of P.6.1.77 (*iko yaṇ aci*). The rule has provoked many controversies and we cannot go into those details here. For details see: Deshpande (1981), p.61, and Cardona (1980-81), pp. 396ff.. A forthcoming monograph by Robert Hueckstedt is devoted entirely to the considerations arising out of the interpretation of this rule.

21. P.1.1.10 (*nājjhalau*). The exact interpretation of this rule has led to great deal of controversy from the earliest period of the Pāṇinian tradition. For details, see Madhav Deshpande (1975), pp. 61-69. Also see: Bare (1976), pp. 95, 97, 113-115.

22. For further discussion, see Madhav Deshpande (1975), pp. 138-140, Bare (1976), pp.185-192 and Cardona(1983), pp.13-31.

23. Bare (1976), pp.144-153.

24. Bare (1976), p. 119.

25. Deshpande (1975), pp. 11-12; Bare (1976), pp.130-140.

26. The short *a* was evidently phonetically [a] in Pāṇini's time, and therefore qualitatively as well as quantitatively different from *ā*, phonetically [aa]. For a detailed discussion of the phonetics of short *a*, see Deshpande (1975b).

27. Deshpande (1975a), Bare (1976), pp. 160-171.

28. Bare (1976), pp. 171-2; Deshpande (1978), pp. 282-285.

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